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DEVELOPMENT OF CERTAIN BLACK SEA FISHES IN SEA CONTAMINATED BY PETROLEUM PRODUCTS

[Razvitiye nekotorykh chernomorskikh ryb v morskoy vode, zagryaznennoy nefteproduktami]

by

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A study was made of the development of the fertilized eggs of Engraulis enrasicholus ponticus Alex., Scorpaena porcus L., and Crenilabrus tinca L. in sea water containing 0.1-0.01 ml/liter petroleum, solar oil, and mazut. The different species sensitivity of the fishes to the petroleum products used was found. The damaging effect of these compounds (death of the organisms) was clearly traced down to a concentration of 0.001 ml/liter. The function was expressed that lower concentrations of petroleum, solar oil, and mazut were also proved toxic for the hydrobionts. The consequences of this

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intoxication can be reflected not in the direct death of the roe or prelarvae, but in the later stages of development or in future generations.

Data on the effect of petroleum contamination on the embryonic development of marine hydrobionts, in particular, fishes, are extremely limited. Our observations (Mironov, 1967) show that the developing roe of the Black Sea brill flounder is highly sensitive to petroleum products in sea water. In 1967-1968, series of experiments were conducted to find the effect of different concentrations of petroleum contaminants on the developing roe of the Black Sea anchovy (Engraulis enrasicholus ponticus Alex.), scorpion fish (scorpaena porcus L.), and the green wrasse (Crenilabrus tinca L.). This selection of organisms made it possible to trace the developing pelagic and benthic roe in conditions of petroleum contamination. The experimental method was similar to the one used earlier (Mironov, 1967), with the exception of the experimental material. In the present study, fertilized roe from netted samples or natural egg masses was selected for the experiments.

The stages of roe development are indicated after T. V. Dekhnik (1961).

The development of the fertilized anchovy roe in different concentrations of petroleum and petroleum products is shown in Fig. 1. Roe from the third developmental stage was taken for the experiment. A high death rate of the developing roe was observed when the petroleum products were at a concentration of 0.1-0.001 ml/liter. Solar oil proved to be the most toxic: in this case, by the fifth developmental stage 20-30 percent of the roe persisted without visible pathological changes. The natural death of the roe in the control did not exceed 20 percent. At the moment of hatching of the prelarvae, the roe that had been at the sixth developmental stage was viable at all concentrations of petroleum and mazut, while this was true in solar oil only at

Table 1

Survival rate of anchovy prelarvae in different petroleum concentrations (percent of live prelarvae)

a Концентрация нефтепродуктов, мл/л	b Личинки из икры, бывшей в нефти				c Личинки из икры, не подвергавшейся действию нефти			
	d сутки опыта							
	1	2	3	4	1	2	3	4
Нефть e								
0,1	—	—	—	—	0	—	—	—
0,05	0	—	—	—	50	0	0	0
0,01	0	—	—	—	70	30	0	0
0,001	70	30	0	0	70	40	10	0
Соляр f								
0,1	—	—	—	—	0	—	—	—
0,05	0	—	—	—	80	0	—	—
0,01	0	—	—	—	80	0	—	—
0,001	70	0	—	—	90	40	20	10
Мазут g								
0,1	—	—	—	—	0	—	—	—
0,05	60	10	0	—	40	20	0	—
0,01	100	30	0	—	60	30	10	0
0,001	100	30	0	—	60	40	20	0
Контроль h	100	50	30	30	90	90	60	20

Key:
a. Concentration of petroleum products, ml/liter
b. Prelarvae from roe present in petroleum
c. Prelarvae from roe not subject to petroleum
d. Days of experiment
e. Petroleum
f. Solar oil
g. Mazut
h. Control

[Translator's note: Commas in the tabulated figures are equivalent to decimal points.]

0.05-0.001 ml/liter. However, the hatching of prelarvae in water contaminated with petroleum and mazut at a concentration of 0.1 ml/liter, and when the solar oil concentration was 0.05 ml/liter did not commence. The subsequent fate of the prelarvae is shown in Table 1.

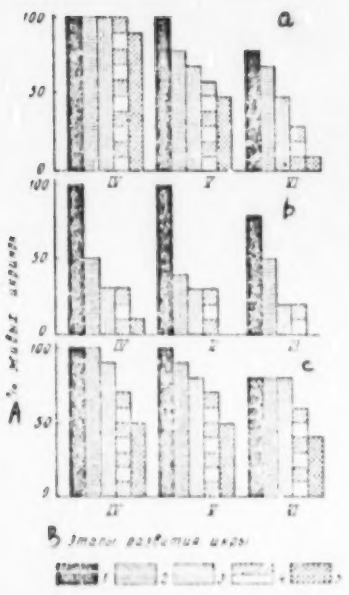

Fig. 1: Development of fertilized anchovy roe at different concentrations of petroleum, solar oil, and mazut
a. petroleum
b. solar oil
c. mazut
Concentrations, ml/liter:
1. control
2. 0.001
3. 0.01
4. 0.005
5. 0.1
Key: A. Percent of live ova
B. Developmental stages of roe

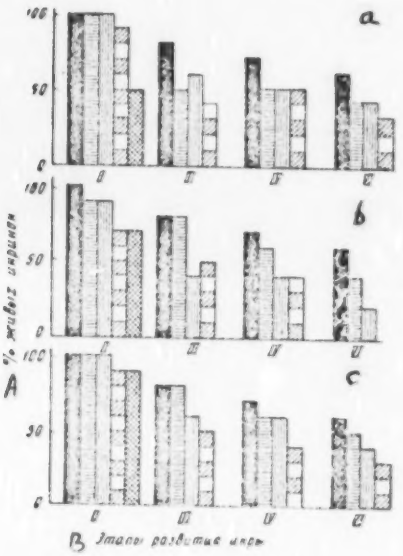

Fig. 2: Development of fertilized scorpion fish roe at different concentrations of petroleum, solar oil, and mazut
The symbols are the same as in Fig. 1.
Key: A. Percent of live ova
B. Developmental stages of roe

By the end of the first day, 70 percent of the larvae remained alive only at minimum concentrations of petroleum and solar oil. Most of them had various anomalies (mainly a curvature of the body). On the second day all the prelarvae perished in water contaminated with solar oil, while 30 percent of slow-moving individuals remained in the water contaminated with

petroleum. During the first days the larvae showed virtually no difference in viability from the control, in water contaminated with mazut. The number of anomalous larvae was 60 percent for the 0.05 ml/liter concentration, while for 25-45 percent at the concentrations of 0.01-0.001 ml/liter. By the end of the second day, the death rate of the prelarvae at minimum mazut concentrations was 20 percent higher than in the control. On the third day all the prelarvae in water contaminated with mazut died; the control individuals stayed alive 2 more days.

Thus, in experimental conditions a 100 percent death rate of the prelarvae of flounder was observed in sea water contaminated with petroleum and petroleum products at concentrations of 0.1-0.01 ml/liter. Even without visible pathological changes, the prelarvae succumbed earlier than the control individuals.

To study the effect of petroleum on the prelarvae of roe that had not been in contact with petroleum, individual experiments were set up; their results are given in Table 1. The most mobile prelarvae, without visible pathological changes, were taken for the experiment soon after hatching. By the end of the first day of being in sea water containing petroleum products at a concentration of 0.1 ml/liter, all the prelarvae had died. At the remaining concentrations, 40-90 percent of the viable organisms remained. In subsequent days, there was a gradual increasing death rate of the individuals, several times higher than in the control. The preliminary time spent by developing roe in sea water contaminated with petroleum products accelerated the subsequent death of the prelarvae.

The development of scorpion fish roe in different concentrations of petroleum products is shown in Fig. 2. At a concentration of 0.1 ml/liter, the roe died in the second in the III developmental stage. At lower

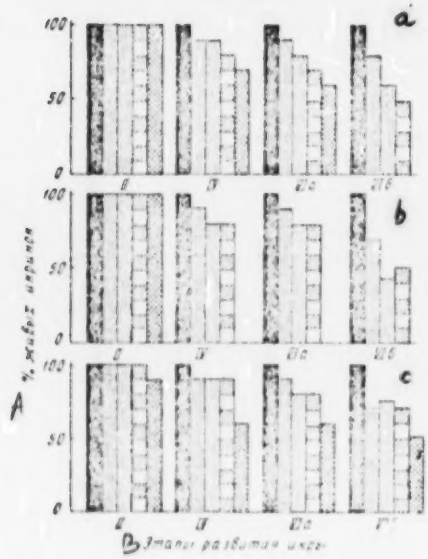

Fig. 3. Development of fertilized green wrasse roe at different concentrations of petroleum, solar oil, and mazut
The symbols are the same as in Fig. 1.

Key: A. Percent of live ova
B. Developmental stages of roe

concentrations, the ova succumbed at a higher rate in the subsequent stages. By the moment of prelarval hatching, the amount of roe without visible pathological changes remaining in the water contaminated with petroleum (depending on concentration) was 30-40 percent, in water contaminated with solar oil -- 20-40 percent, and in water contaminated with mazut -- 30-50 percent. Just as for anchovy roe, solar oil proved to be more toxic. Thus, petroleum, mazut, and solar oil in concentrations of 0.1-0.001 ml/liter act toxically on developing flounder roe.

Table 2

Amount of viable roe in experiment by the end of the IV developmental stage, percent of control

a Концентрация нефтепродуктов, мл/л	b Хамса	c Ерш	d Зеленушка
e Нефть			
0,1	12	0	0
0,05	38	50	60
0,01	62	67	50
0,001	88	67	80
f Соляр			
0,1	0	0	50
0,05	25	0	70
0,01	25	33	80
0,001	38	67	70
g Мазут			
0,1	50	0	0
0,05	75	50	50
0,01	100	67	40
0,001	100	83	70

Key: a. Concentration of petroleum products, ml/liter
b. Anchovy
c. Scorpion fish
d. Green wrasse
e. Petroleum
f. Solar oil
g. Mazut

The initial petroleum and petroleum products had a specific gravity less than one and at first was at the surface of the water. However, due to various factors (physical, chemical, and biological, these compounds rapidly emulsified and penetrated deeper into the water and the soil, where they could accumulate in considerable amount. In these conditions petroleum contamination affects the benthic organisms, and also the benthic developmental stages of several hydrobionts.

The effect of petroleum contamination on the green wrasse is shown in Fig. 3. In contrast to the two first species that had pelagic roe, the roe of the green wrasse developed in masses firmly secured to a substrate. A

characteristic point of distinction from the two preceding species is the considerable resistance of green wrasse roe to petroleum contamination. By the end of the VI stage at all petroleum and mazut concentrations, 60-90 percent of the roe remained, developing without visible pathological changes. At solar oil concentrations of 0.1 ml/liter, all the roe perished, while at lower concentrations the death rate did not exceed 10-20 percent. In our experiments, from the beginning of the VI stage to the hatching took about three days. During this time part of the roe in the experiments succumbed, while the percentage of viable ova was considerable higher than by the end of the sixth developmental stage for anchovy and scorpion fish.

As we can see from the figures, by the beginning of the prehatching of anchovy larvae 80 percent of the roe remained viable in the control, 60 percent of the control scorpion fish roe, but 100 percent of the control green wrasse roe. Thus, it can be assumed that the high stability of the green wrasse roe to petroleum contamination is responsible for its higher viability. To revise this finding, the percent of ratio of the amount of roe remaining viable by the end of the VI stage in the experiment to the corresponding amount in the control was calculated (Table 2).

It was found that the high stability of green wrasse roe to petroleum contamination cannot be accountable only by its greater viability. Evidently, the developing roe of this species is more resistant to petroleum contamination, in particular to crude petroleum and solar oil. Interestingly enough, solar oil has a less destructive effect on the green wrasse roe than on the anchovy and scorpion fish roe. And conversely, mazut proved to be more toxic. Therefore, in this case a different species sensitivity to the same compound became evident. Flounder roe also proved more sensitive to mazut.

Thus, the destructive effect of petroleum contamination is shown in all the concentrations tested (0.1-0.001 ml/liter) of petroleum products, expressed in the death of the developing fish roe. We did not test high concentrations of the petroleum products, however it can be assumed that even they would not be indifferent for the species. The consequences of this action can be reflected not only in the direct destruction of the developing ovae or prelarvae during the experimental period, but in the later stages of ontodenesis. Possibly, the consequences of hydrocarbon intoxication will be reflected in the state of subsequent generations. The final answer can be obtained only after appropriate experiments, and carrying these out poses considerable difficulties.

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